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Nuclear charge radii of magnesium isotopes by laser spectroscopy with combined fluorescence and beta-decay detection

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The nuclear charge radius is a critical probe for testing nuclear models and detecting anomalies in the nuclear structure. The isotopic chain of magnesium exhibits intruder configurations with the pf shell being populated before the sd shell is complete. In this "island of inversion"the nuclear charge radii would indicate this structural change, expected to happen in the step from 30Mg to 31Mg, and in such a way answer the question if deformation is the driving force behind this phenomenon.
The experimental property providing the charge radius is the isotope shift, i.e. the shift in frequency of an atomic transition in different isotopes. The magnesium isotope shifts were measured by collinear laser spectroscopy making use of the versatility of this technique. For the exotic even-odd neutron rich magnesium isotopes 29,31Mg we used optical pumping to polarize the nucleus and detected the asymmetry in the beta decay after implantation in a MgO host crystal. It is the first time that beta-asymmetry measurements are applied for isotope-shift measurements, which became possible only after a thorough understanding and simulation of the observed line shapes. The equivalence of optical and beta detection was investigated on the basis of 29Mg, which was accessible with both methods. 27Mg and the even-even isotopes, 24,26,28,30,32Mg were measured with conventional fluorescence detection. Photon-ion coincidence provided a critical improvement of the signal-to-noise ratio for the measurement of the very exotic isotope 32Mg.
The results of the measurements on 24-32Mg will be presented the charge radii that can be extracted from the isotope shifts and compare them with the trends predicted on the basis of models and experimental information.

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